Long Wavelength Hyperspectral Imaging Applications 12 Oct 2000

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TOPICS

- ***Hyperspectral Concept Design Application***
  - *Hyperspectral Imager (HSI) for Target Detection and Cueing*
    - *LWIR Spectral Band for Day/Night Operation*
    - *High Spectral Sensitivity (Low NESR)*
    - *High Spectral Fidelity (Low Optical Distortion)*
  - *High Resolution Imager (HRI) for Image Analysis*
    - *High Spatial Resolution (High NIIRS Rating)*
    - *MWIR Spectral Band for Day/Night Operation*
- ***Hyperspectral Tactical Demonstrator System Design***
  - *Lower Cost System to Prove LWIR HSI Performance*

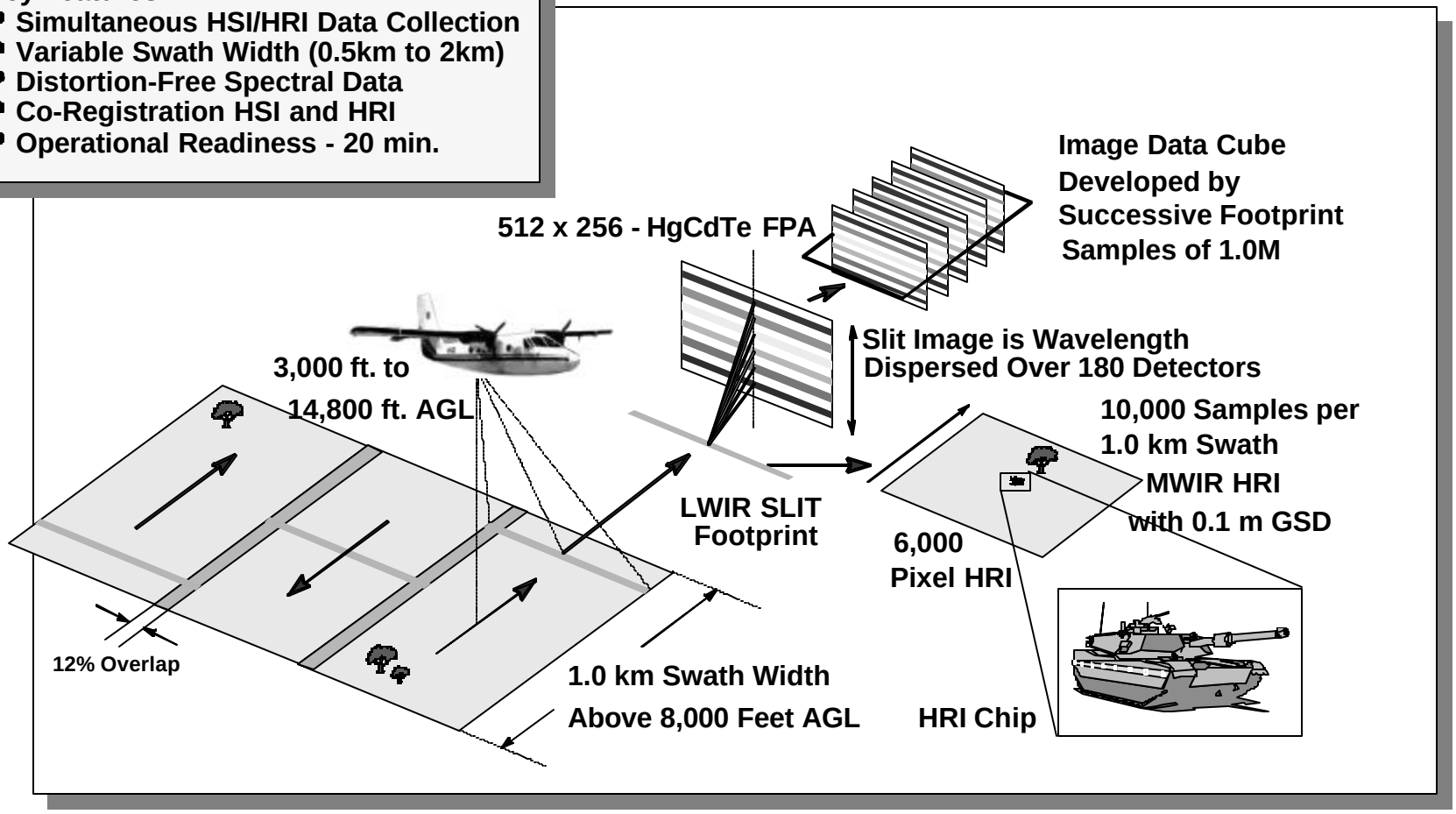
Hyperspectral Sensor System (HSS) Concept Design

Concept Design Objective

- ***Provide Tactical Design for LWIR Hyperspectal Application***
  - *Hyperspectral Imager to Generate Data Cube*
  - *High Resolution Imagery for Image Analysis*
  - *On-Board Target Detection Processor*
  - *Tactical Package for Airborne Platforms*

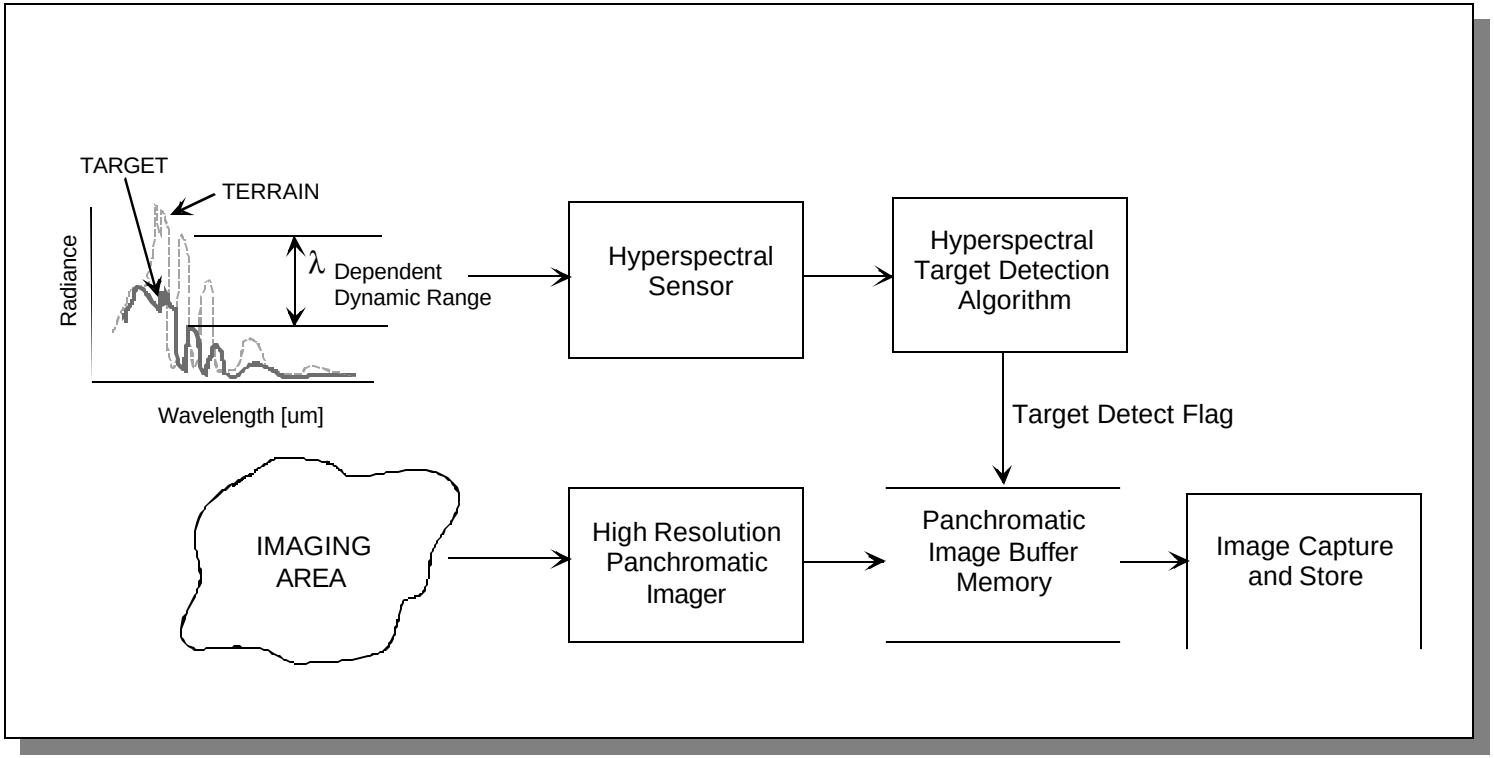
Hyperspectral Application System Concept Design

Key Features:
- Simultaneous HSI/HRI Data Collection
- Variable Swath Width (0.5km to 2km)
- Distortion-Free Spectral Data
- Co-Registration HSI and HRI
- Operational Readiness - 20 min.



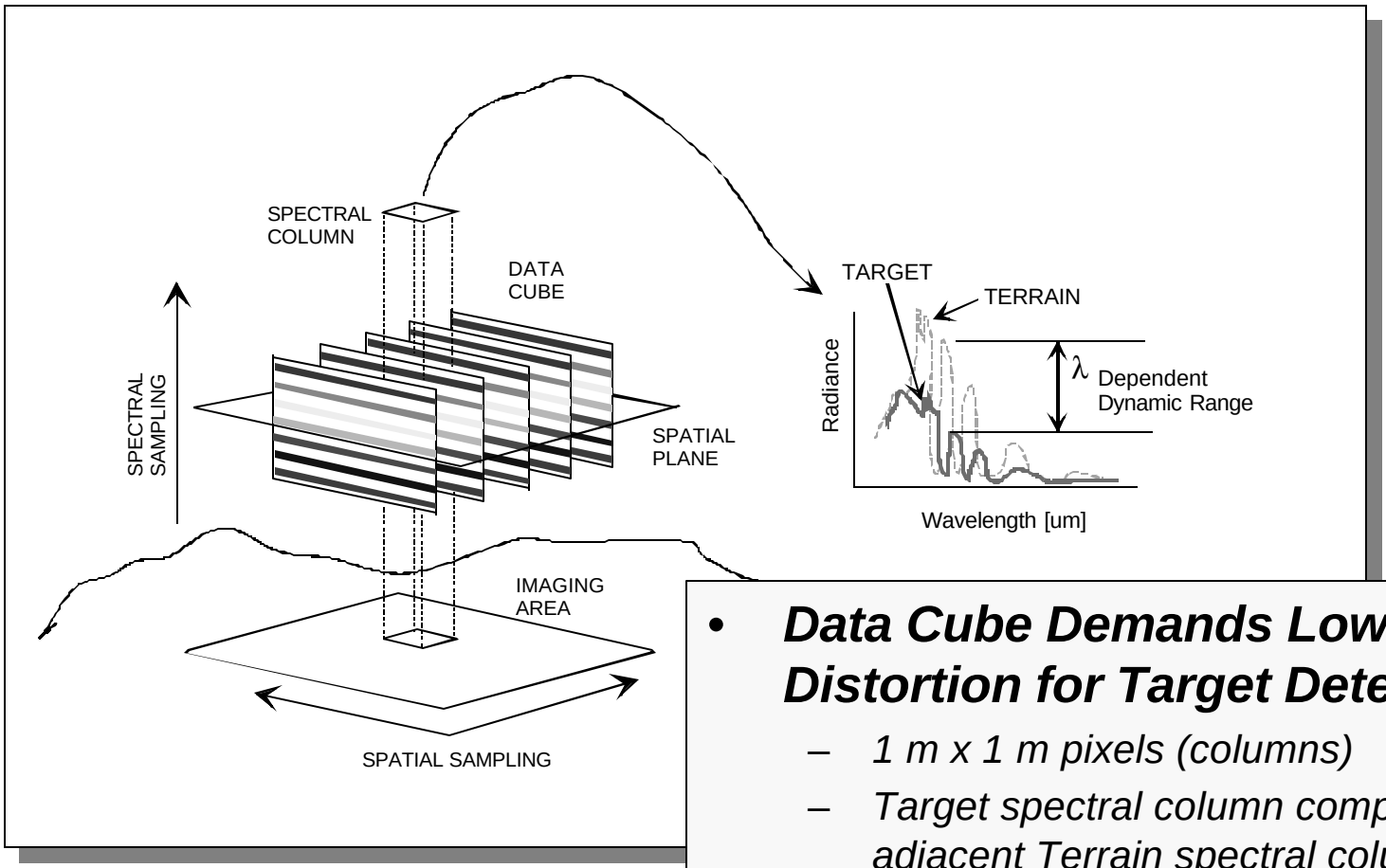
Pan-Scan Provides Flexible Architecture for High Ground Coverage

Target Detection and Cueing Application



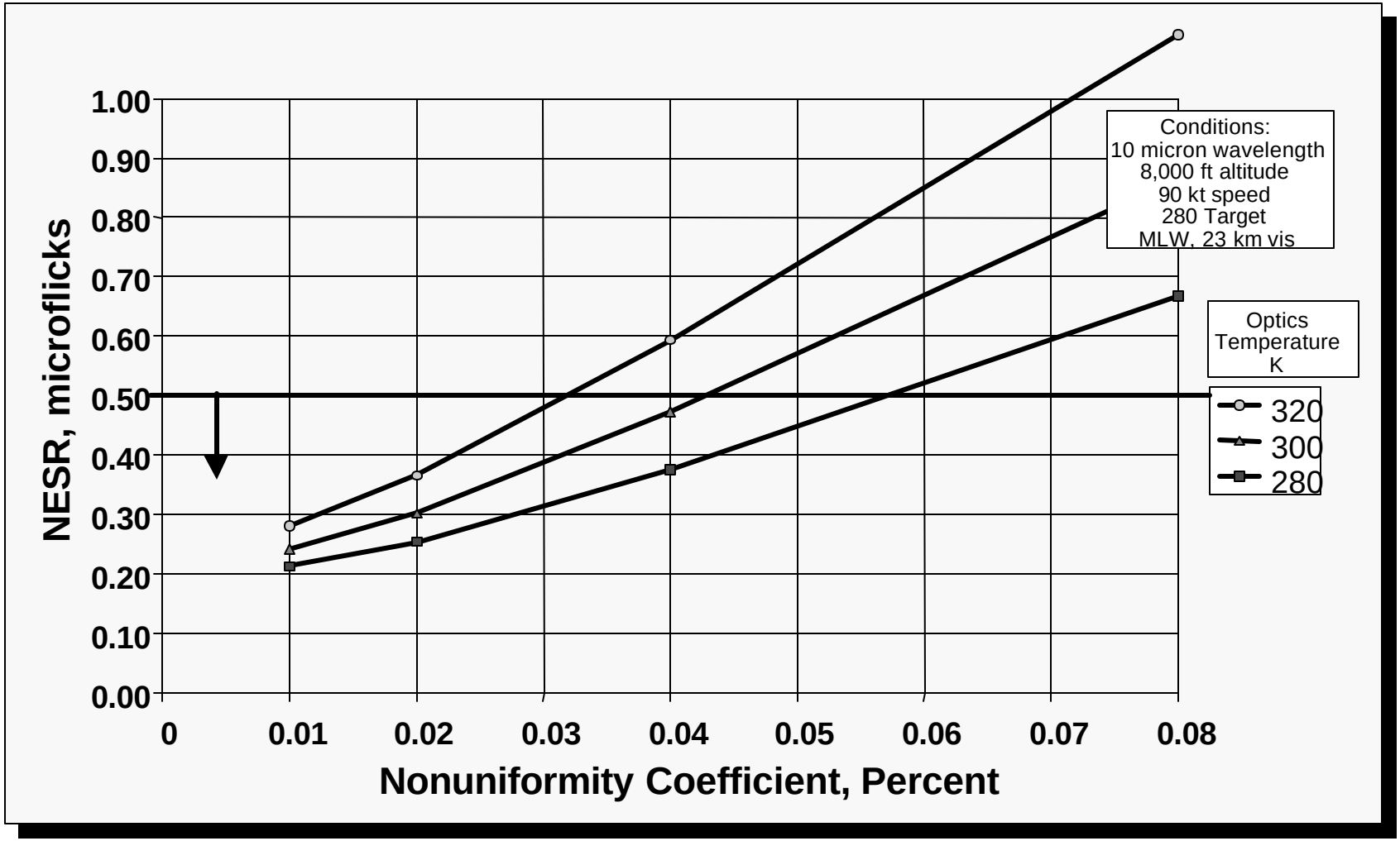
- ***Target Detection and Cueing Application***
  - *Target Spectrum Separated from Terrain Spectrum*
  - *LWIR Hyperspectral Sensor Provides NESR <0.5 mFlicks for Target Automatic Detection*
  - *High Resolution Imager Provides >NIIRS 6 Imagery for Target Visual Identification*
  - *Image Buffer Holds HRI Imagery*
  - *Target Detect Flag from High Speed Algorithm Processor Cues Image Buffer*
  - *Visual Image Captured & Stored for Imager Interpreter*

Hyperspectral Data Cube



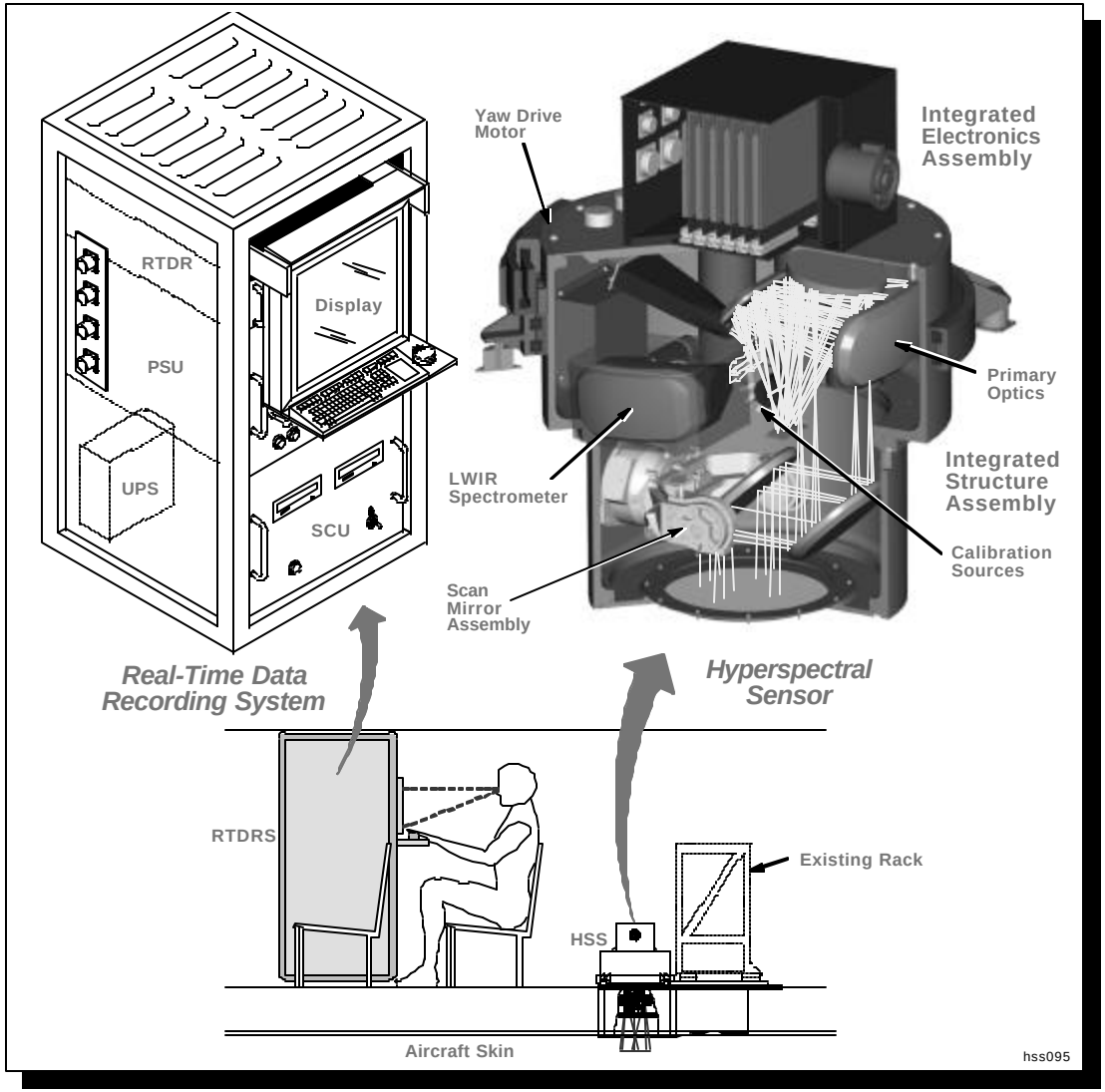
- ***Data Cube Demands Low Spectral Distortion for Target Detection***
  - *1 m x 1 m pixels (columns)*
  - *Target spectral column compared to adjacent Terrain spectral columns*
  - *Demands Low Distortion in Optics to maintain high spectral fidelity in spectral column*

LWIR NESR Demands NUC Correction

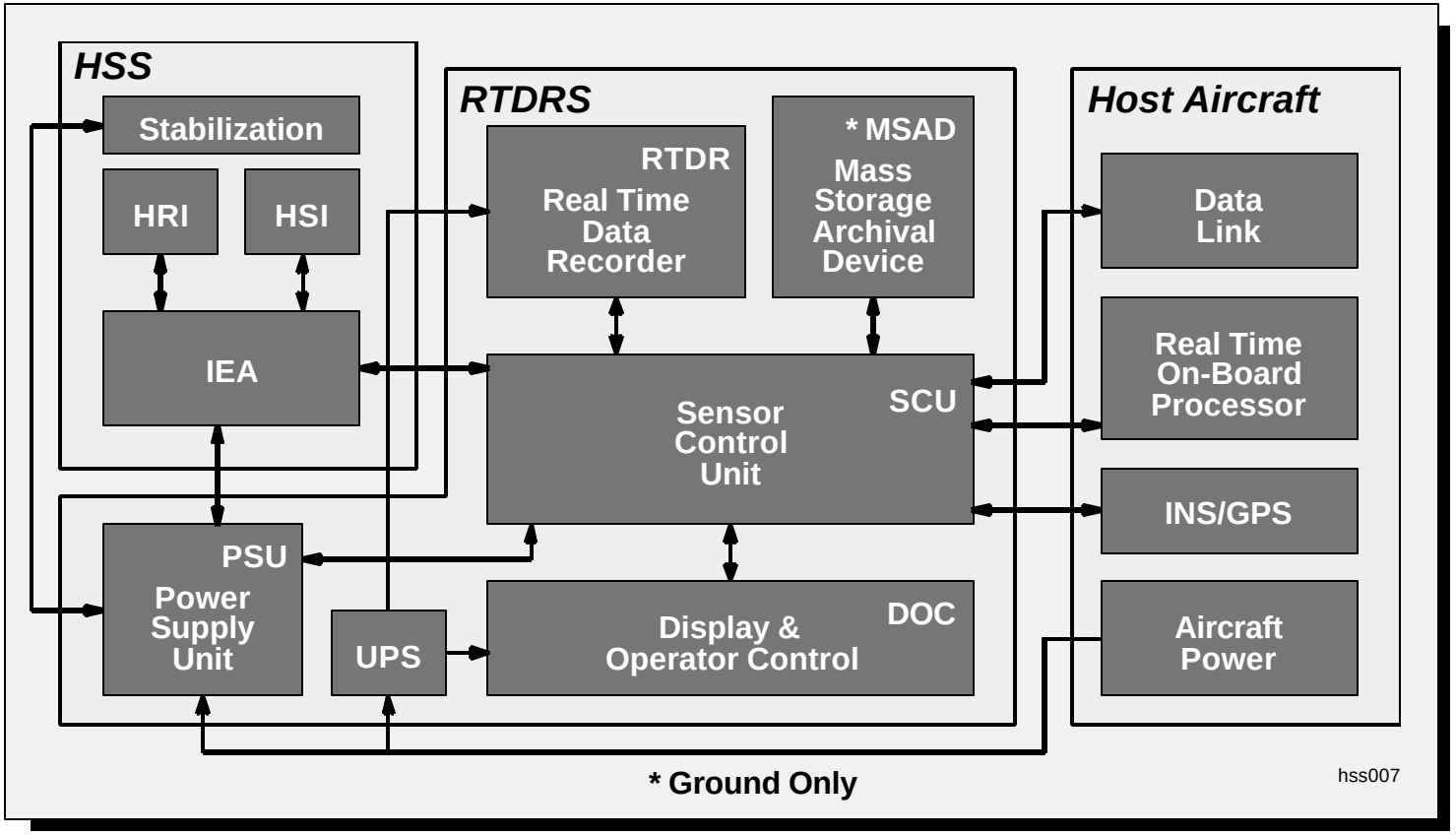


Target Detection Demands NESR < 0.5 mFlicks

HSS Concept Design

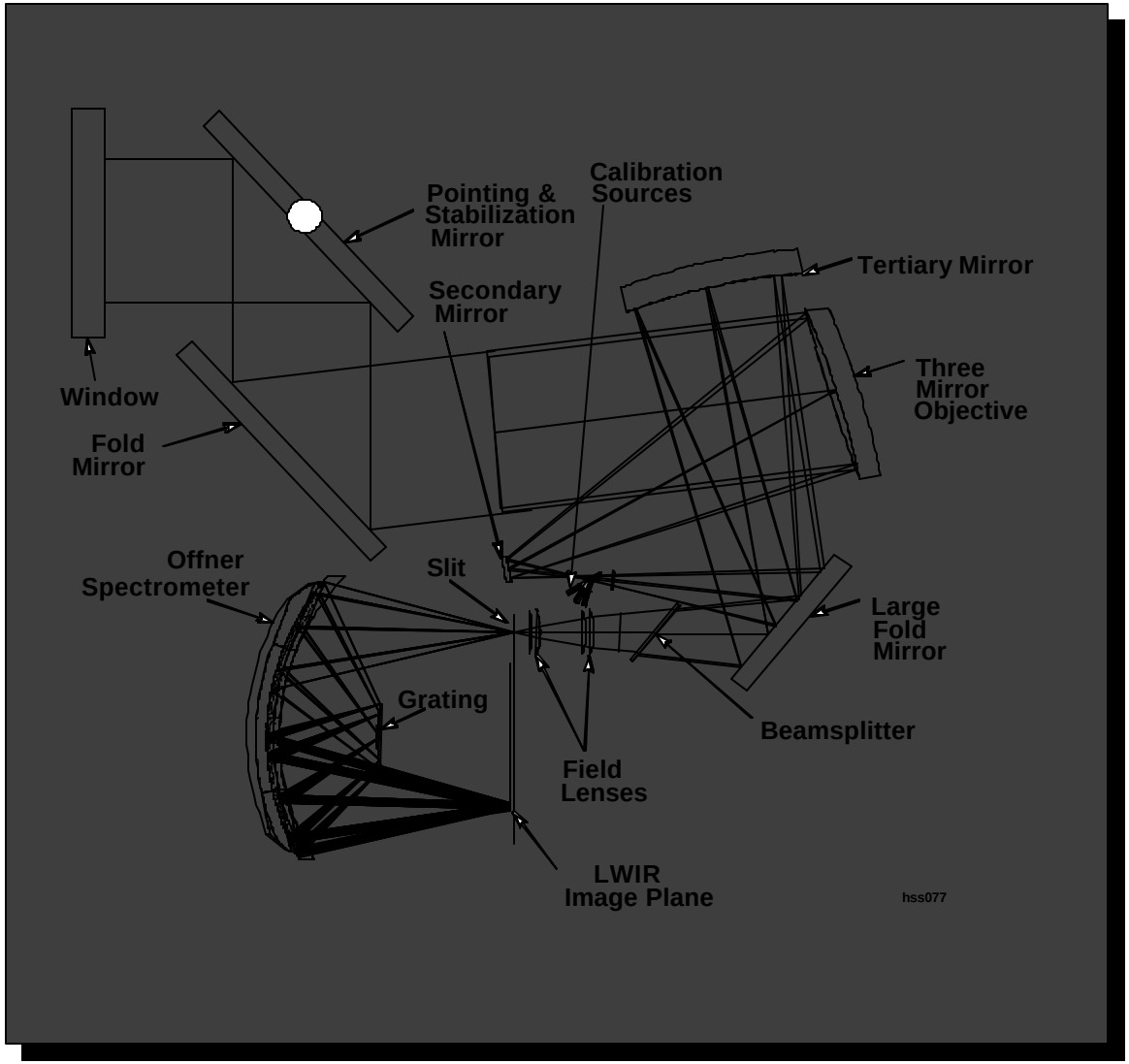


HSI/HRI Block Diagram



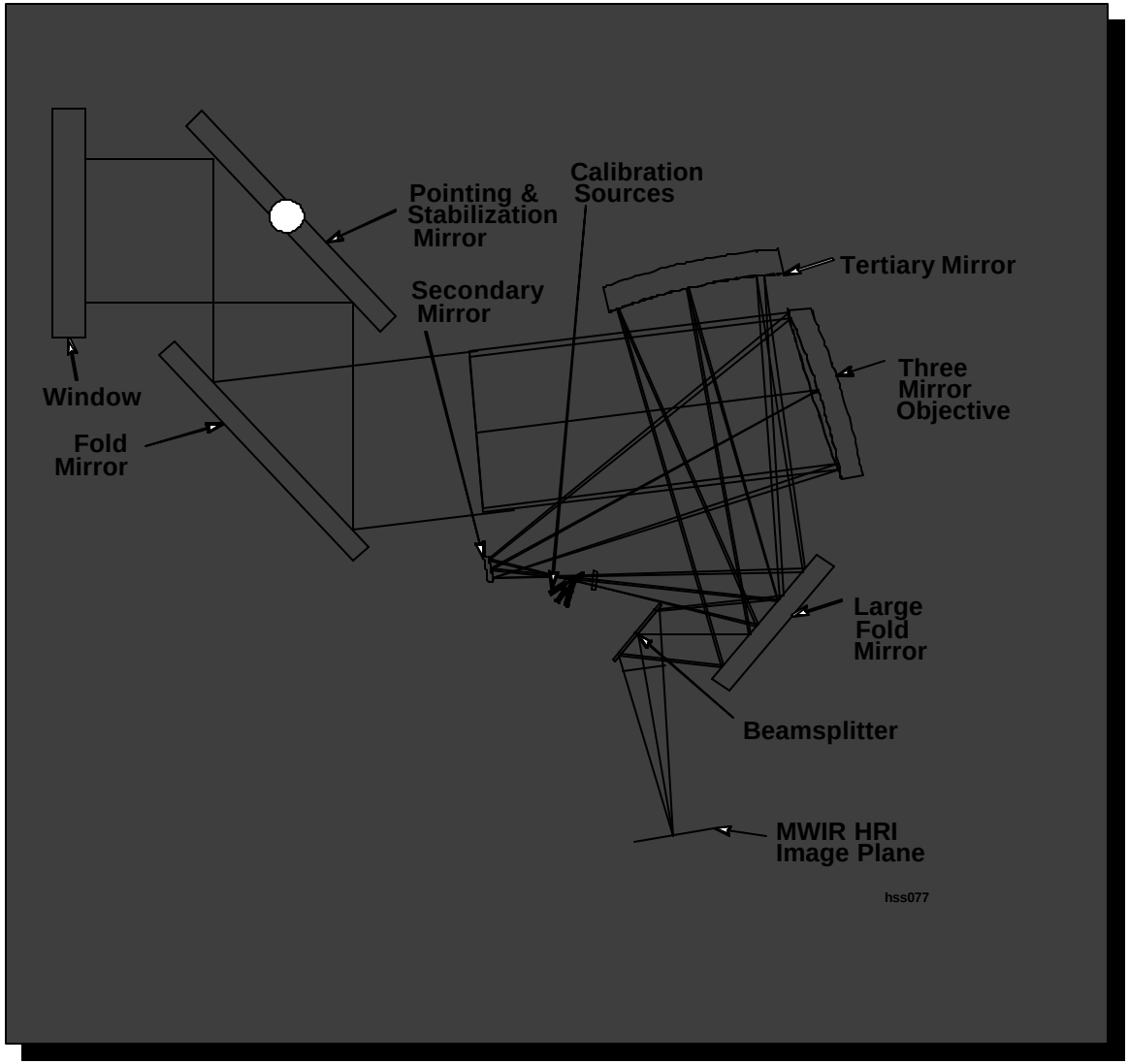
HSI Optics Shares Common Telescope

- *LWIR HSS shares three-mirror front telescope with MWIR HRI*
- *Germanium beamsplitter transmits LWIR.*
- *Field lenses change telescope focal length from 18 inches to 7.5 inches and provide a telecentric image for the slit.*
- *Well-corrected F/2.0 image at slit allows modular alignment and test.*
- *Accessible intermediate image permits field stop stray light baffling.*



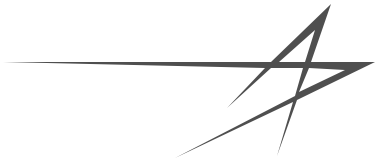
HRI Optics Share Common Telescope

- *LWIR and MWIR share common front telescope folded in a compact assembly.*
- *Three-mirror anastigmat design meets specified performance over the full field-of-view.*
- *Unobscurred, reflective design minimizes background radiation.*
- *Accessible, real exit pupil permits 100% geometric cold shielding.*
- *Accessible intermediate image permits field stop for stray light baffling.*
- *Beamsplitter separates MWIR (reflected) and LWIR (transmitted).*



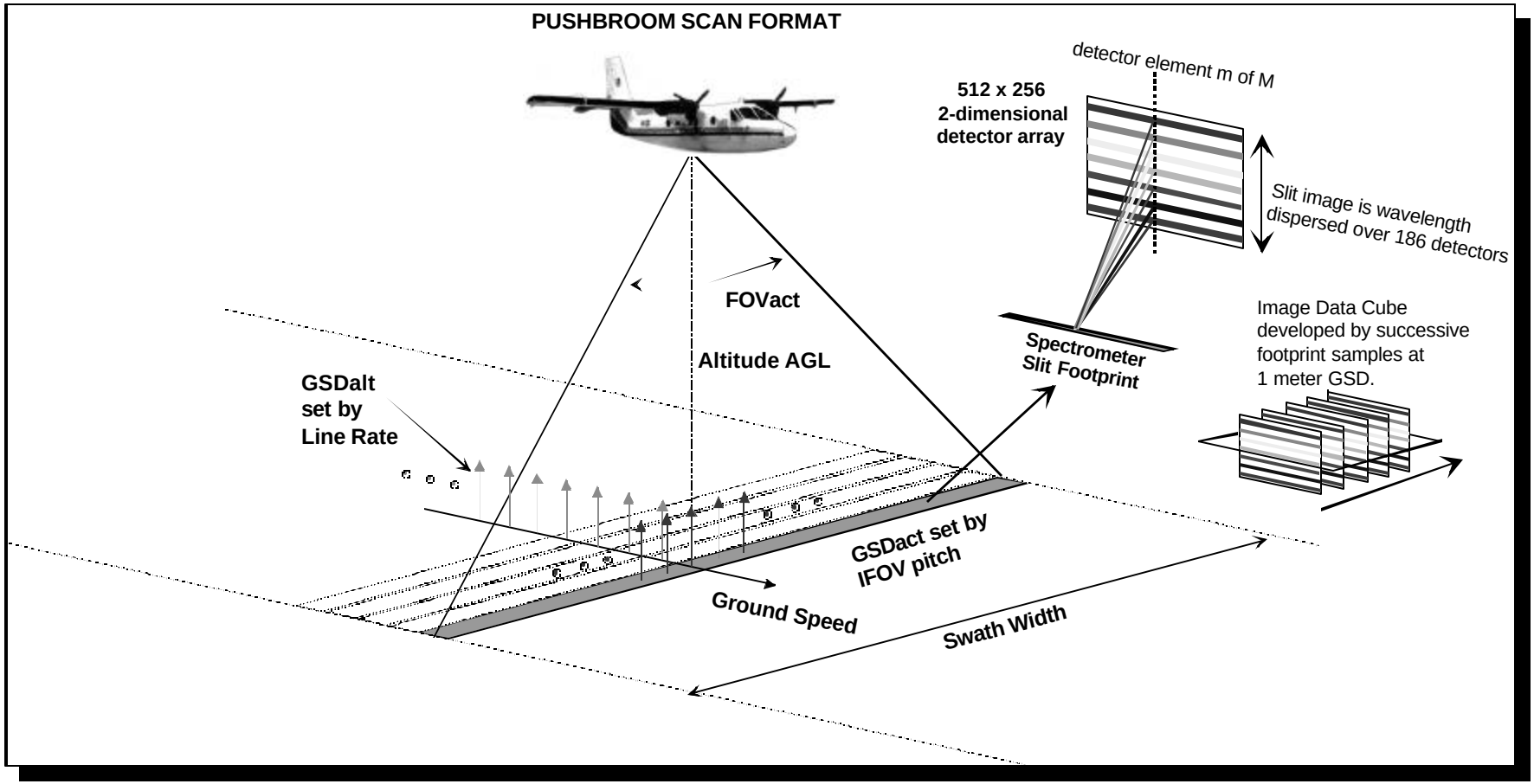
Hyperspectral Long Wave Imaging for the Tactical Environment (HyLITE) Tactical Demonstrator System (TDS) Design

HyLITE TDS Objectives



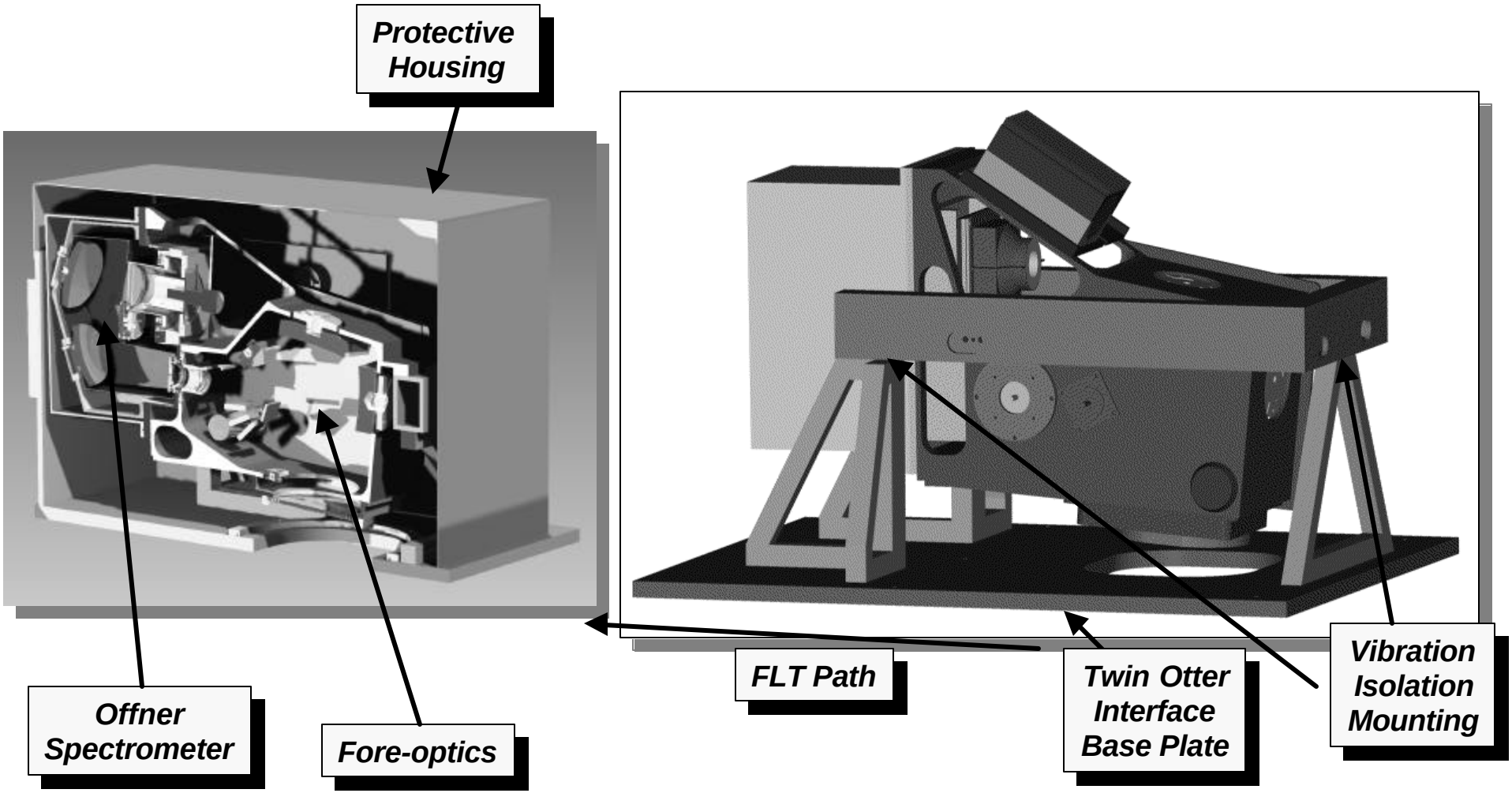
- ***Demonstrate LWIR Spectrometer Performance***
  - *Spatial Resolution*
  - *Spectral Resolution and Data Cube Fidelity*
  - *NESR Sensitivity*
- ***Demonstrate Airborne Target Detection Capability***
  - *RTOP LWIR Detection Algorithms*
- ***Store LWIR Spectrometer Field Data***
  - *Archive for Ground Tests of Real Airborne Data*
    - *Post Flight Ground Testing*
    - *Distribute for Laboratory Testing*

TDS Operational Scenario



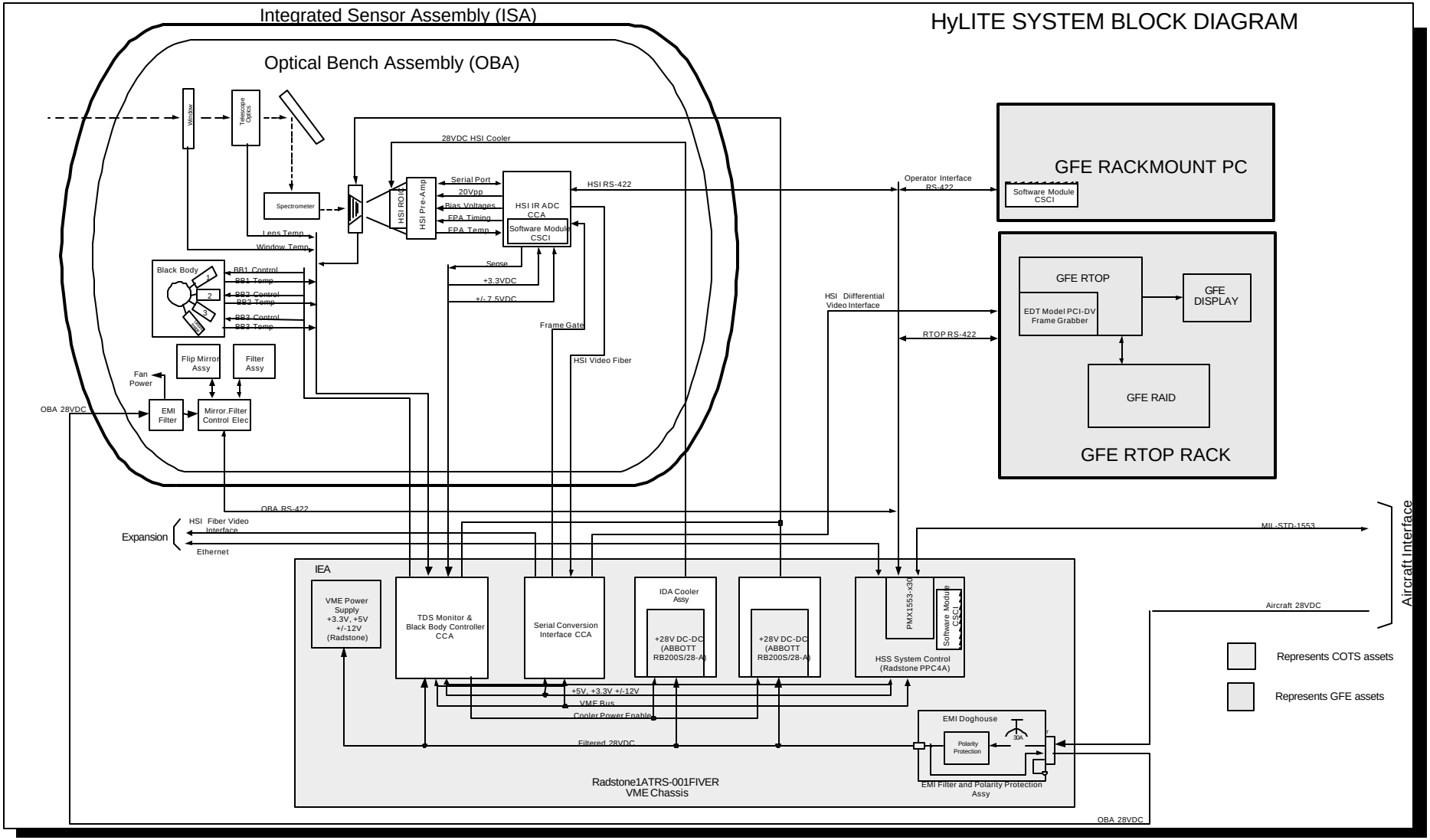
Pushbroom Provides Simple Installation for Demonstration System

LWIR HyLITE Tactical Demonstrator System Design

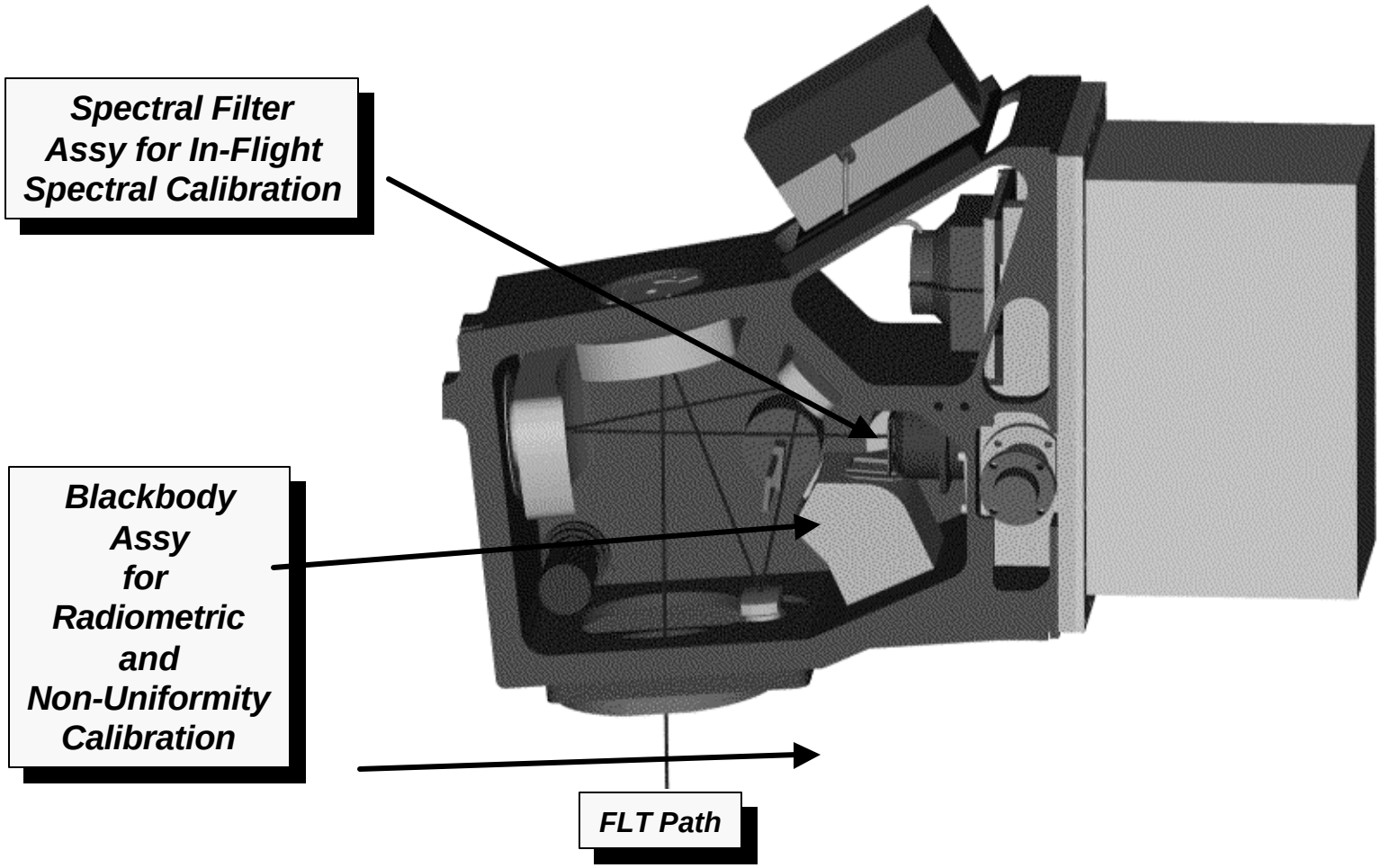


TDS Packaged for Demonstration

TDS Block Diagram

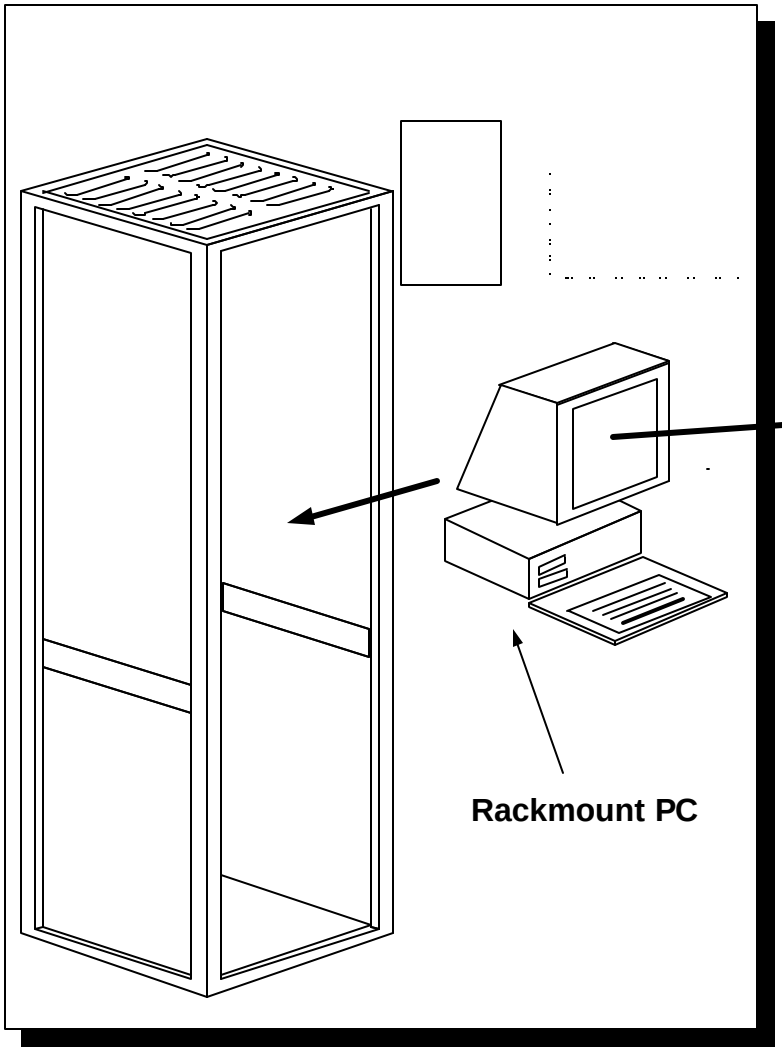


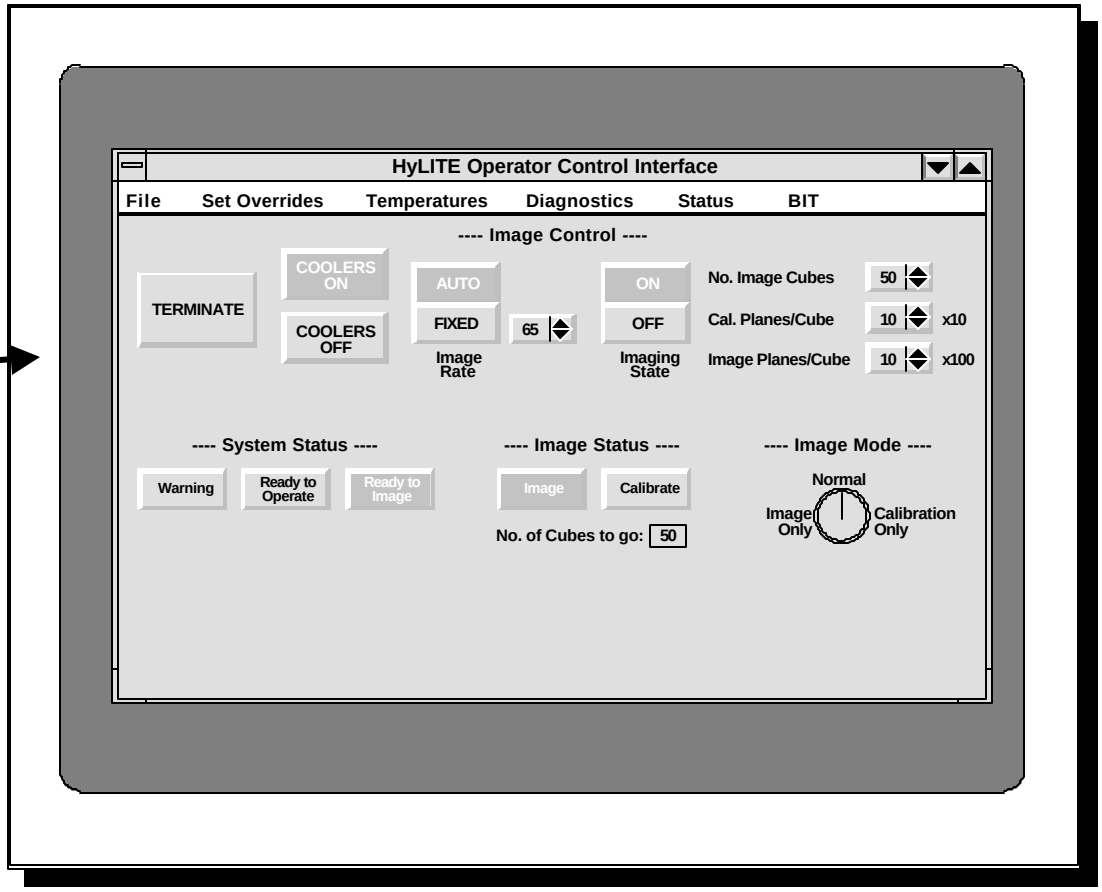
TDS Internal Features



On-Board Calibration System

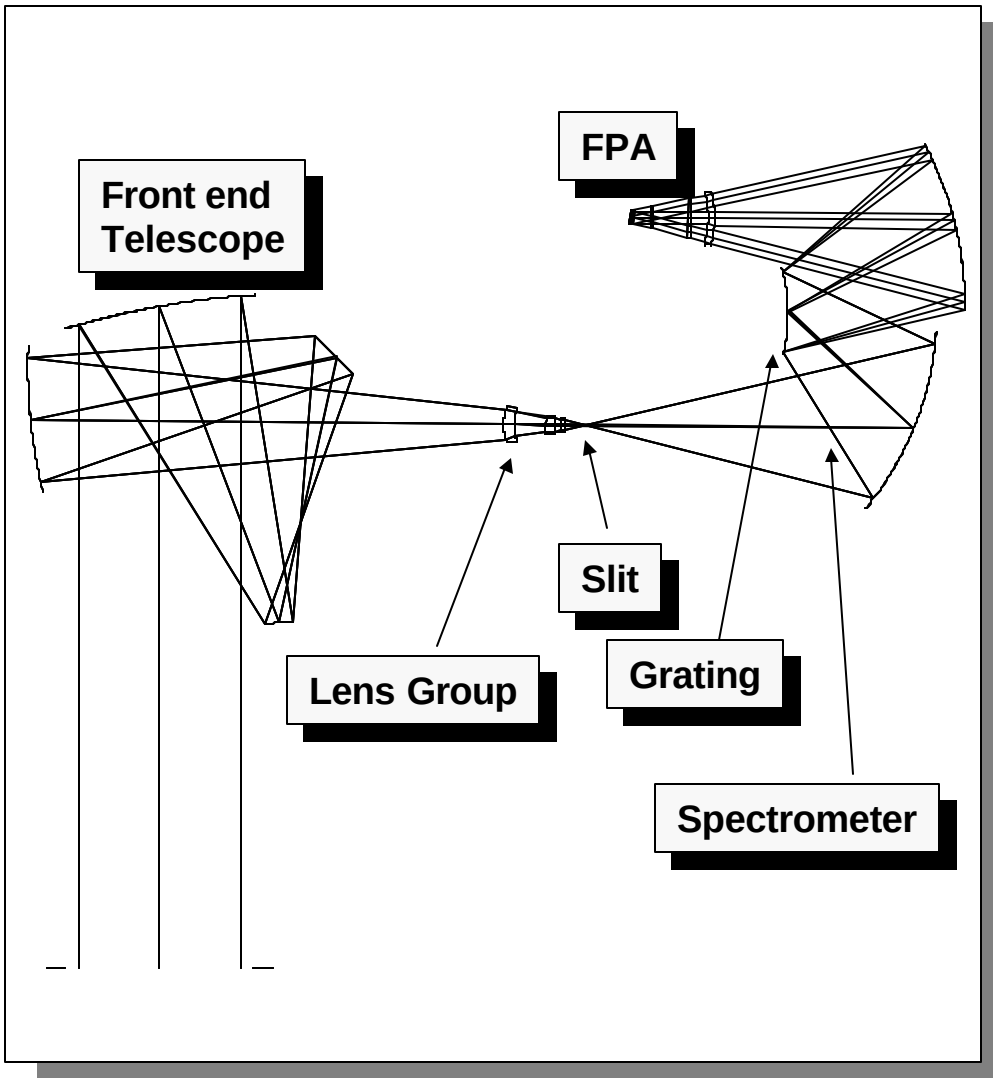
TDS Operator Control Interface





Rackmount PC Provides Operator Interface with TDS

TDS Optical Design



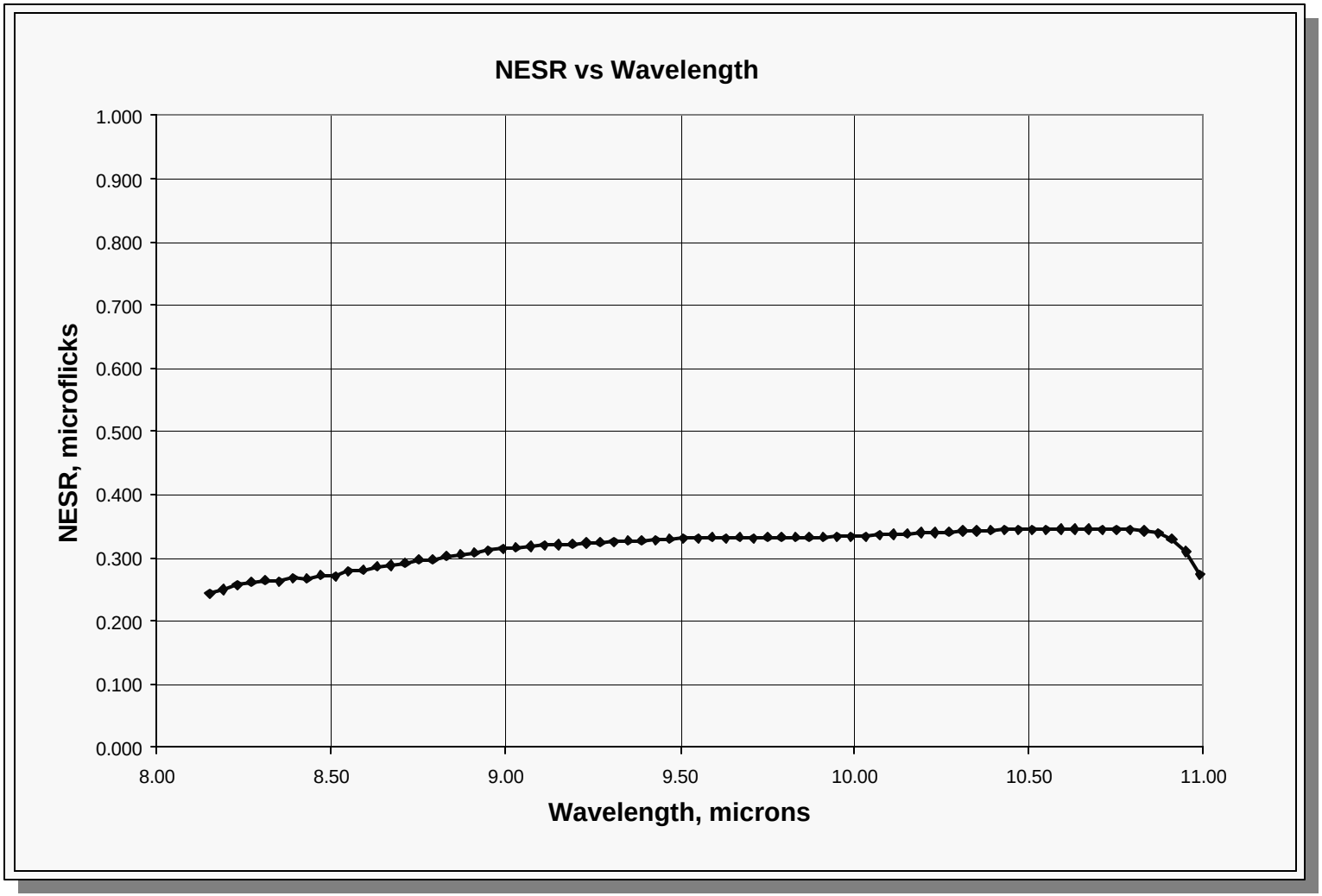
- *The Front-End Telescope is a classic Three Mirror Anastigmat (TMA). All of the mirrors have standard null tests and are diamond turnable.*
- *A 1:1 imaging Offner type spectrometer relays the slit image to the Focal Plane.*
- *The grating is on the secondary mirror of the spectrometer.*

TDS Spectrometer Performance

Parameter	Design
Effective Focal Length	7.50” ± 3.0%
Aperture Diameter	3.75”
F/Number	2.0
Field-of-View	6.16 Deg
Spectral Distortion (Smile)	< 1/10 Spectral Channel
Keystone Distortion	< 1/10 Spatial Sample
Operational* Optics MTF (12.5cycles/mm) (no grating degradation)	>0.5 spatial across most of the format.
Spectral Band	7.95 um – 11.05 um
Spectral Channel	50 nm

Optics Provides Low Distortion Data Cube

TDS NESR Performance



SUMMARY

- ***HSS Concept Design Illustrates Tactical Package***
  - *Hyperspectral Target Detection Cueing*
  - *High Resolution Imagery for Image Interpreter*
    - *> NIIRS 6*
- ***HyLITE TDS Provides Field Test Demonstration***
  - *Demonstrates Hyperspectral Sensor for Tactical Environment*
    - *Spectrometer Performance*
    - *Target Detection Performance*
    - *Growth to Tactical Package*